Integrated Nutrient Management Planning on Dairy Farms

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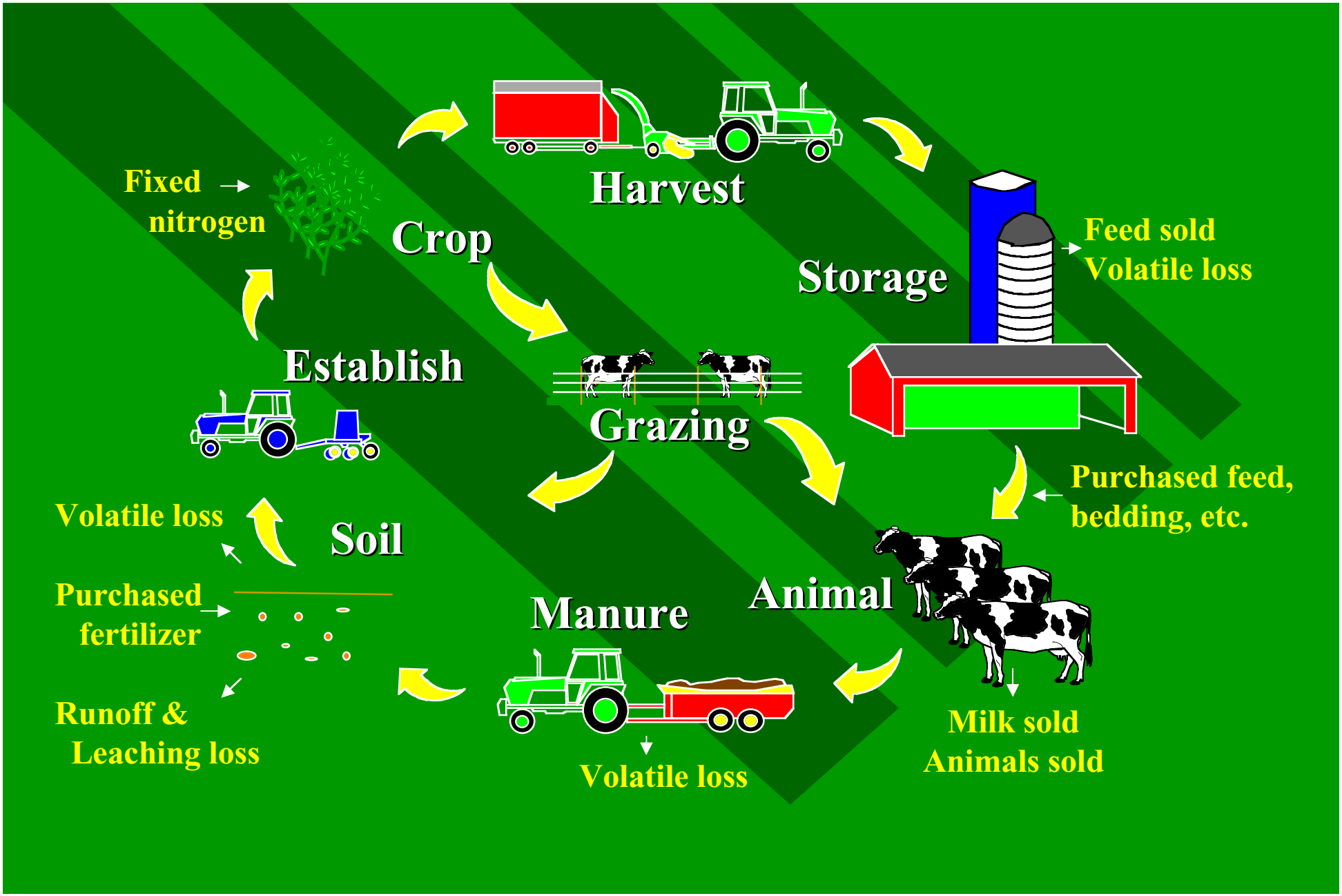
Pasture Systems and Watershed Management Research Unit

USDA, Agricultural Research Service
University Park, Pennsylvania


Harvest
Crop
Fixed nitrogen
Establish
Storage
Feed sold
Volatile loss
Grazing
Purchased feed, bedding, etc.
Animal
Soil
Volatile loss
Purchased fertilizer
Runoff & Leaching loss
Manure
Volatile loss
Milk sold
Animals sold

Nitrogen & Phosphorus

Nutrients Excreted

- **Nitrogen**
  - **Organic N (40 –50% of total)**
  - **Urea (50 –40%)**
- **Phosphorous**
  - **Water soluble (30 –50%)**
  - **Water insoluble (50 –70%)**

Nutrient Transformations

- **Nitrogen**
  - **Urea → Ammonia**
  - **Organic N, relatively stable**
- **Phosphorous**
  - **Relatively stable**

Factors Affecting N Loss

- Barn temperature
- Time of exposure
- Amount of urea N
- Handling method
- Barn ventilation
- Separation of urine and feces

N Loss in the Barn

- 5 –90% of the ammonia can be lost in the barn
- Thus, total N loss varies from very little up to about 50%
- An average loss is about 30% of total N

Factors Affecting N Loss

- Amount of remaining ammonia N
- Ambient temperature
- Wind speed
- Type of storage
- Manure loading method
- Cover

N Loss from Storage

- Up to 100% of the remaining ammonia N can be lost
- Total N loss

Aerobic lagoon	20%
Top-loaded tank	15%
Bottom-loaded tank	5%
Covered tank	0%

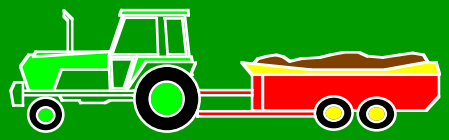
Factors Affecting N Loss

- Amount of remaining ammonia N
- Time until incorporated
- Temperature and wind speed
- Rain

N Loss following Application

- Up to 100% of the remaining ammonia N can be lost
- Total N loss

Surface spread, no incorp.	20%
Surface spread and incorp.	5%
Injected into the soil	0%



Factors Affecting N Loss

- The amount of urea (ammonia) N excreted
- Temperature
- Wind speed
- Rain

Volatile N Loss from Pasture

- About 50% of the ammonia N is lost
- Thus, about 25% of the total N is lost by volatilization

Types of Loss from Land

- Volatile
- Leaching
- Denitrification
- Erosion & runoff

Factors Affecting Loss

- Timing of application vs. crop need
- Rainfall
- Soil temperature
- Soil moisture content
- Nutrient loading of soil

Nutrient Losses

- **Nitrogen**
  - Runoff loss 1 – 2%
  - Leaching loss 5 – 20%
  - Denitrification 3 – 8%
  - Volatile loss 1 – 2%
- **Phosphorus**
  - Runoff loss, not incorp. 5 – 20%
  - Runoff loss, incorp. 1 – 5%
  - Leaching loss 0 – 2%

Phosphorus Index

Transport

- Runoff potential
- Erosion potential
- Leaching potential
- Proximity to stream channel

Source

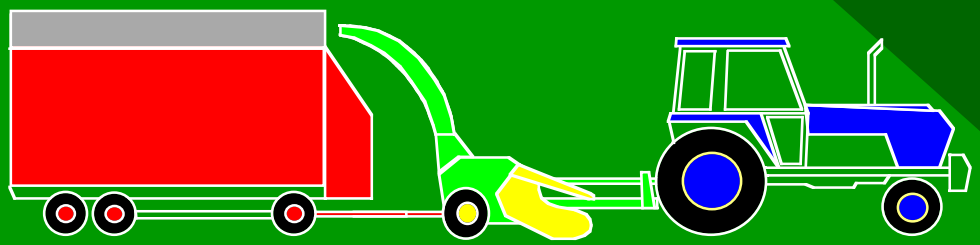
- Soil P content
- Fertilizer P (Rate, method, timing)
- Manure P (Rate, availability method, timing & type)

Site Vulnerability to P Loss


Maintaining a
nutrient balance on
cropland is important

Factors Affecting Loss

- Type of crop
- Harvest method (hay vs. silage)
- Harvest conditions (crop moisture)
- Weather conditions (rain)



Typical Losses

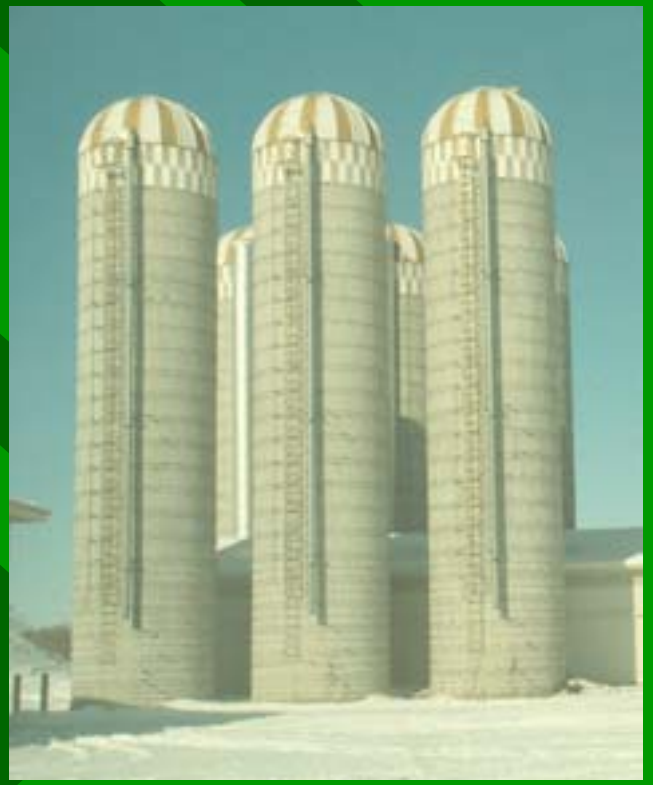
- Nitrogen and phosphorus

Grain	1 — 5%
Hay	20 –40%
Silage	10 –20%

- Losses are returned to the soil, so no real environmental impact

Factors Affecting Loss

- Type of storage
- Crop moisture content
- Weather conditions



Typical N Losses

- Grain 0 – 1%
- Hay, inside storage 8 – 12%
- Hay, outside storage 10 – 20%
- Low moisture silage 0 – 5%
- High moisture silage 5 – 12%

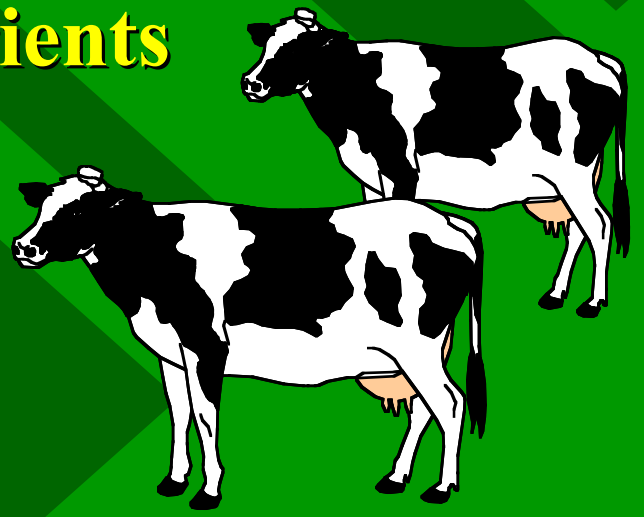
Effluent losses can have a major environmental impact

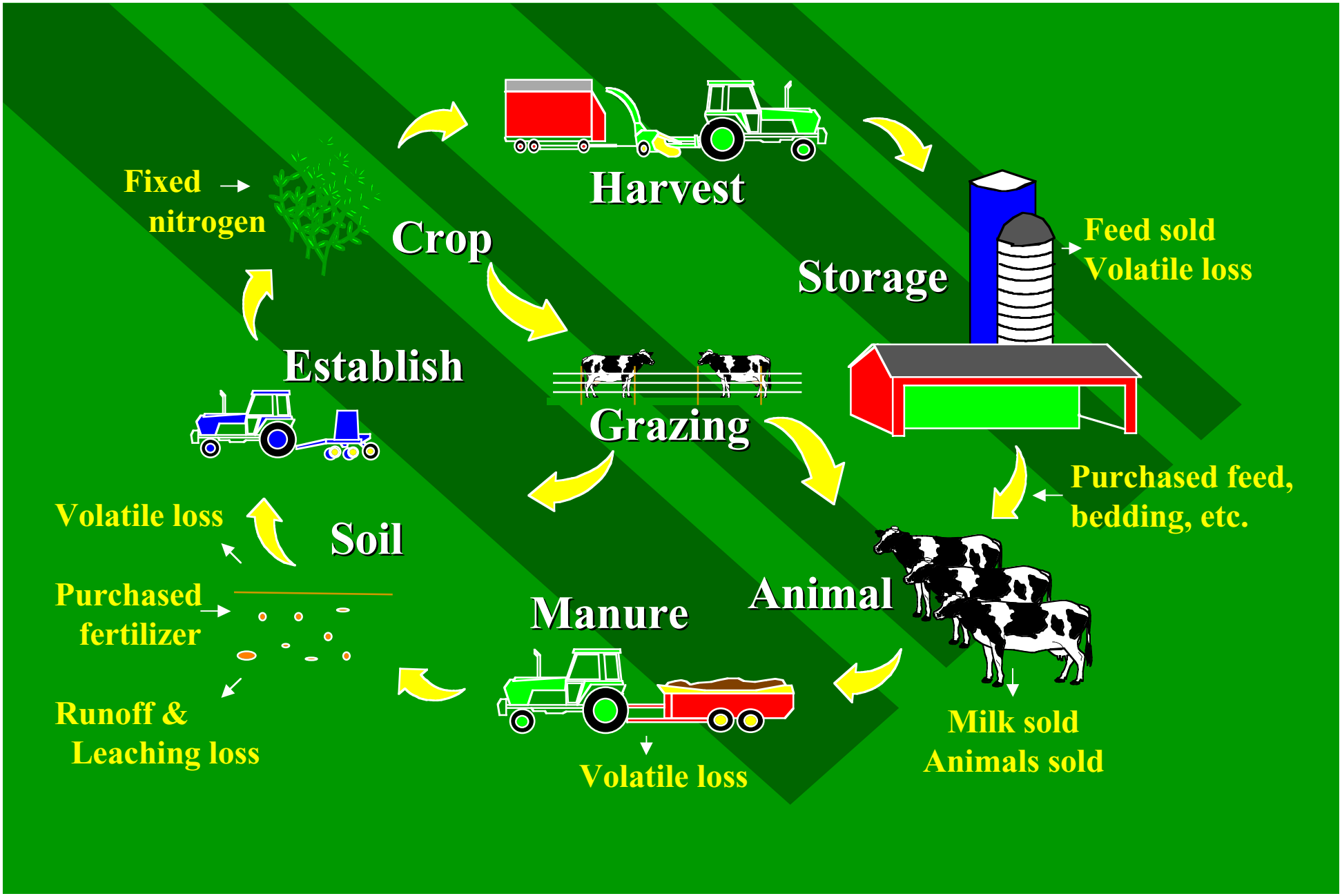
Efficiency of Utilization

$$\text{Use efficiency} = \frac{\text{Nutrients used}}{\text{Nutrients fed}}$$

Factors Affecting Efficiency of use

- Overfeeding of nutrients!
- Proper balance of nutrients
- Feeding method
- Animal differences

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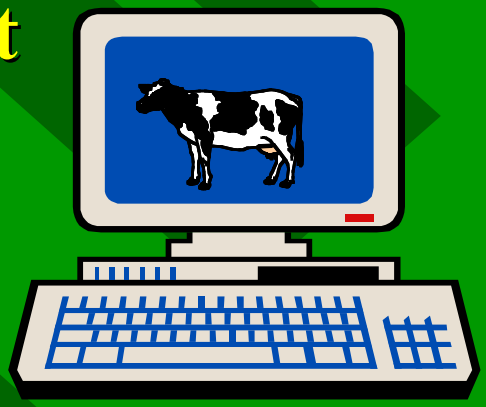
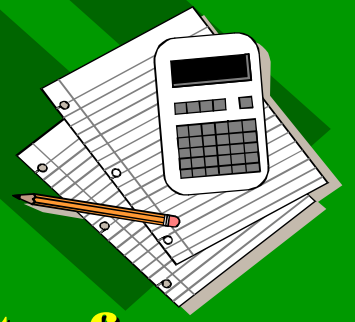
Software Tools

- Prediction of manure nutrient production
- Manure application management
- Long term record keeping
- Costs of manure handling
- Whole farm nutrient balancing
- Nutrient management plan development
- Simulation of production systems



NMP Development Tools

- **Those that assist the preparation of nutrient management plans**
  - Being developed in many states
  - Requires extensive farm information
  - Provides a written plan

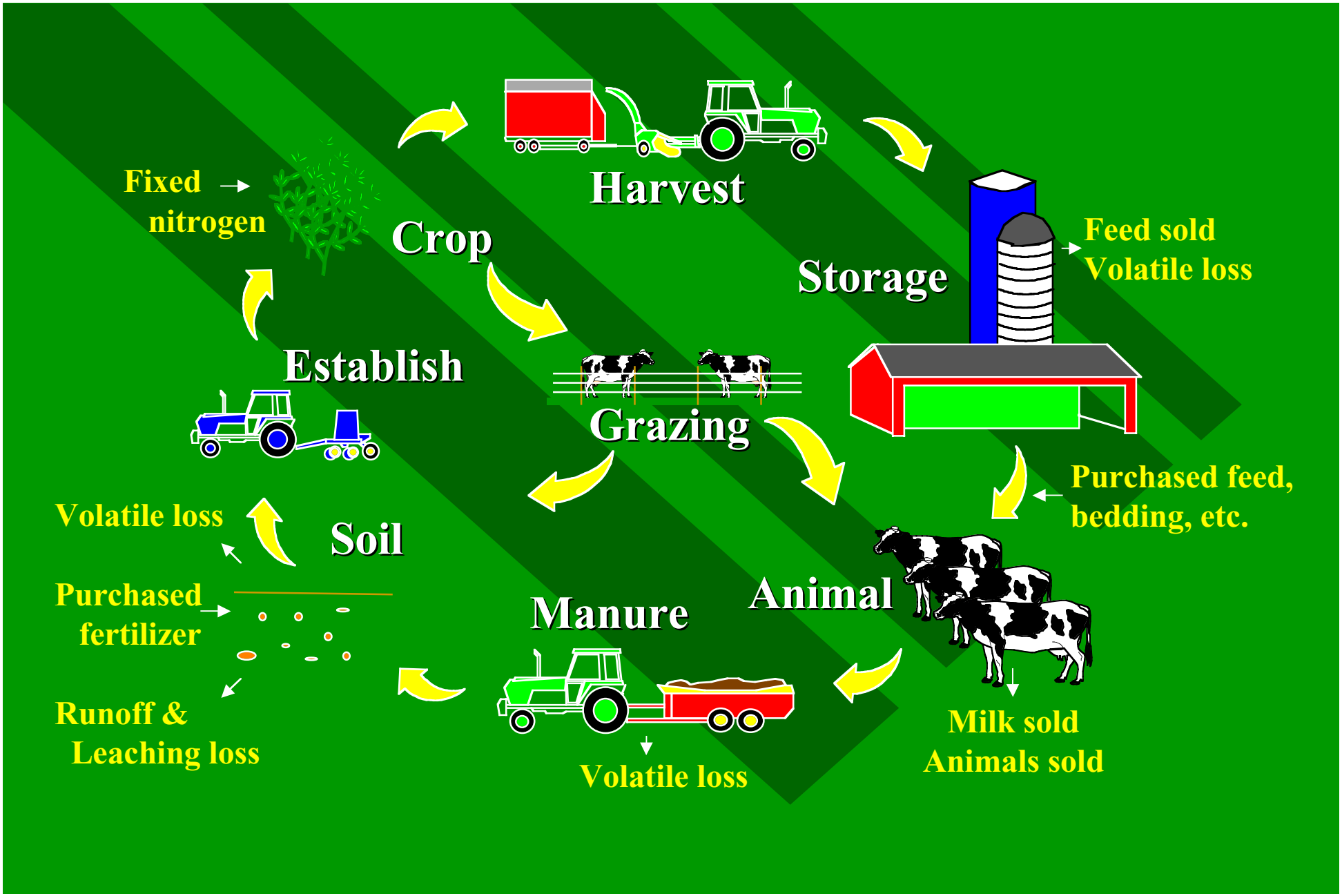


- **Those that assist in the assessment of whole farm nutrient management**
  - Univ. of Penn., Cornell, Maryland, Nebraska
  - Requires extensive farm information
  - Used to assess alternative strategies

Whole Farm Simulation

- Follows farm processes through time
- More comprehensive including weather effects, farm performance and economics
- Better suited to the evaluation of alternative management strategies
- Complex, requires user expertise for use in decision making
- Excellent teaching aid

DAiry FOrage SYstem Model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Dairy Forage System Model
Files Units Input Simulate Plot Options Help
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DAFOSYM
for Windows
Version 4.0
A tool for evaluating and comparing alternative technologies and management strategies on representative dairy farms.
This program is available to download from the address http://pswmru.arsup.psu.edu.
For help, press F1
FARM.FRM
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Animal and Feeding Information

Herd/Facilities | Feeding | Livestock Expenses

Herd

Animal Type :	Holstein	Number of lactating animals :	100
Target milk production :	20000 lbs/cow/year	Young stock over one year :	40
First lactation animals :	35 %	Young stock under one year :	45

Animal Facilities

		Structure cost ($)	Equipment cost ($)
Milking center :	Double six parlor	58000	160000
Cow housing :	Free stall barn	100000	
Heifer housing :	Barn with pens and free stalls	52500	
Feed facility :	Commodity shed	7000	

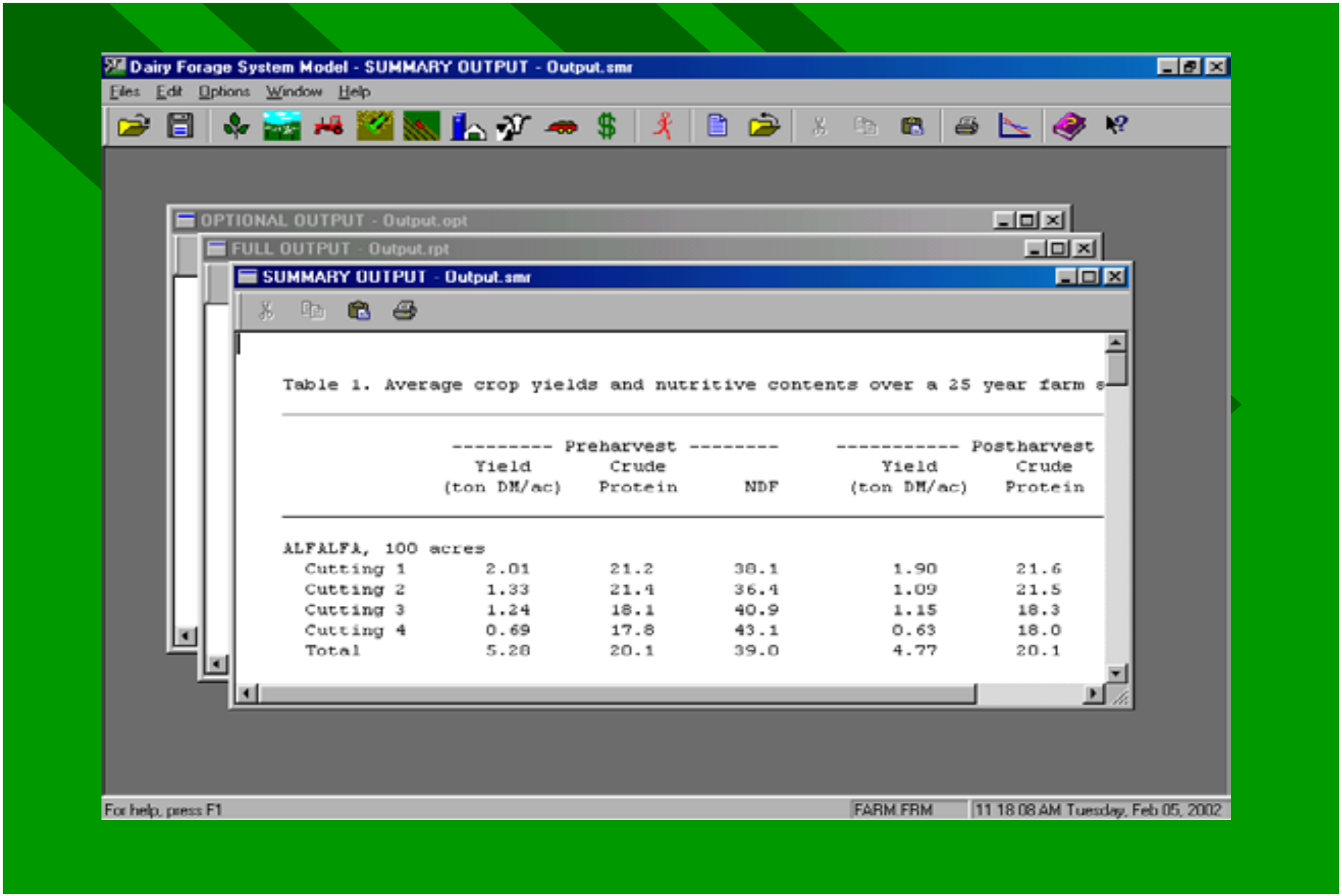
Labor for milking and animal handling : 4.00 minutes/cow/day

Model Input

- Soil characteristics and land use
- Crop parameters
- Grazing information
- Machinery used (owned or custom)
- Tillage and planting strategy
- Harvest strategy

Model Input

- Storage types and size
- Herd description
- Housing and milking facilities
- Feed characteristics and feeding strategy
- Manure handling procedures
- Prices of farm inputs and outputs


Dairy Forage System Model - SUMMARY OUTPUT - Output.smr
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OPTIONAL OUTPUT - Output.opt
FULL OUTPUT - Output.rpt
SUMMARY OUTPUT - Output.smr
Table 1. Average crop yields and nutritive contents over a 25 year farm s
--------- Preharvest --------
Yield (ton DM/ac)
Crude Protein
NDF
---------- Postharvest
Yield (ton DM/ac)
Crude Protein
ALFALFA, 100 acres
Cutting 1 2.01 21.2 38.1 1.90 21.6
Cutting 2 1.33 21.4 36.4 1.09 21.5
Cutting 3 1.24 18.1 40.9 1.15 18.3
Cutting 4 0.69 17.8 43.1 0.63 18.0
Total 5.28 20.1 39.0 4.77 20.1
For help, press F1
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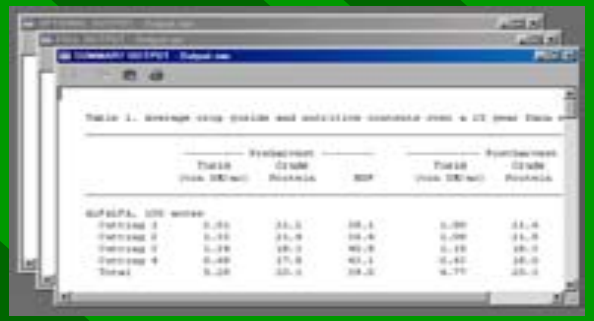
Model Output

- Annual and average crop yields
- Feed production and use
- Animal production
- Resource requirements
- Whole farm nutrient balance with losses
- Production costs, income and net return



Risk

Production Strategies, Phosphorus Management and Profitability of Dairy Farms

C.A. Rotz, A.N. Sharpley, L.D. Satter, W.J. Gburek, and M.A. Sanderson

Pasture Systems and Watershed Management Research Unit
US Dairy Forage Research Center
USDA, Agricultural Research Service

Can management changes be made to reduce environmental impact while maintaining or improving farm profit?

Procedure

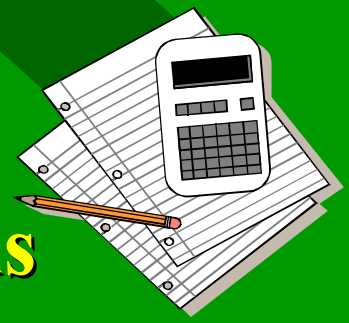
- Model two NY dairy farms
- Simulate current farms for 25 weather years (Cooperstown)
- Verify model predictions with current records
- Simulate alternative management practices

100-cow Farm

- 105 Holstein cows plus 105 heifers
- 21,000 lb/cow milk production
- 450 acres of grass, alfalfa and corn
- Lewbeach, shallow silt loam soil

Model Calibration

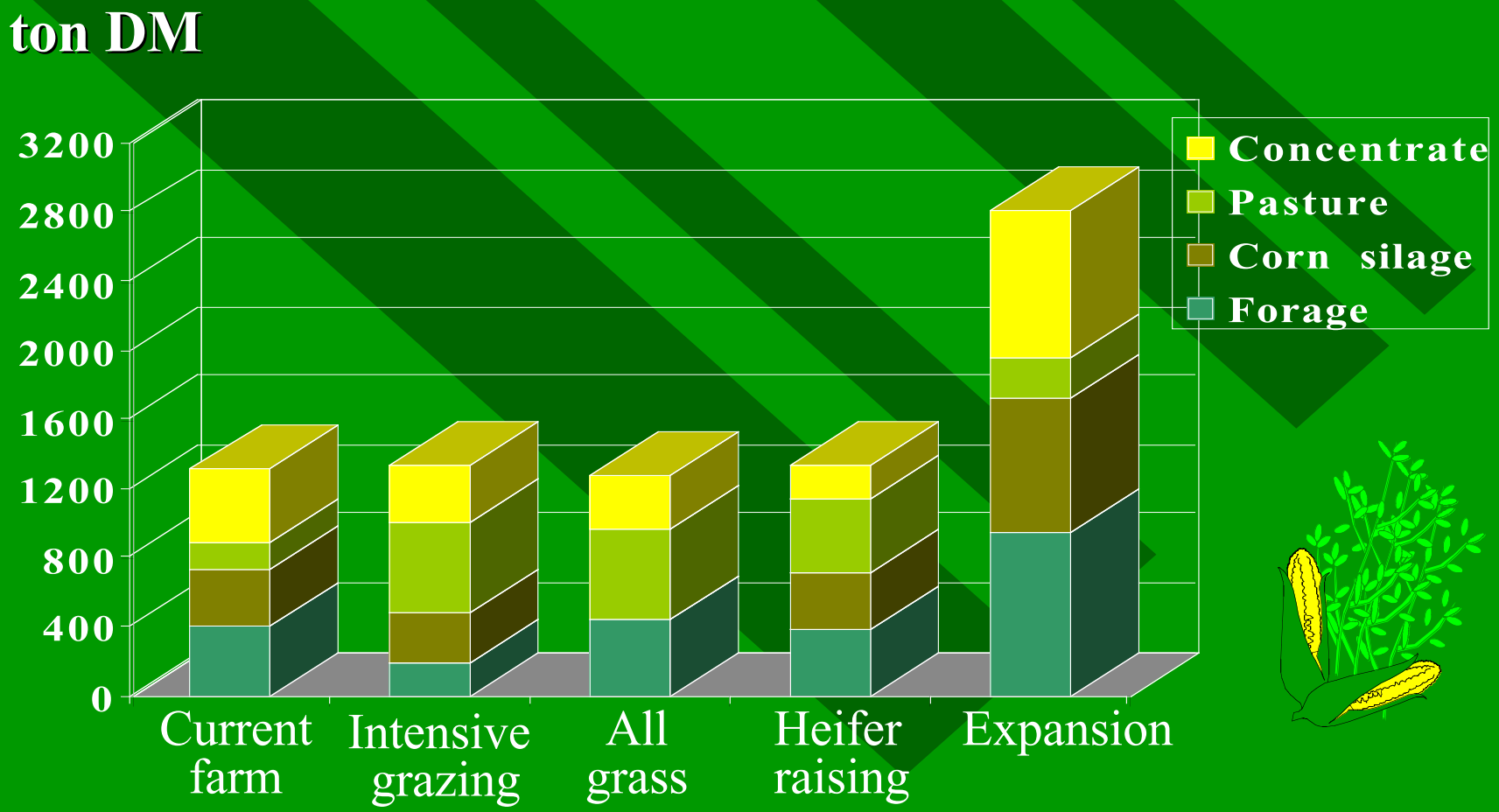
- Simulated production was compared to DHIA records
- Simulated crop yields were compared to county yield data (NYASS)
- Simulated feed consumption was compared to actual feeding records
- Simulated purchased and sold feeds were compared to actual



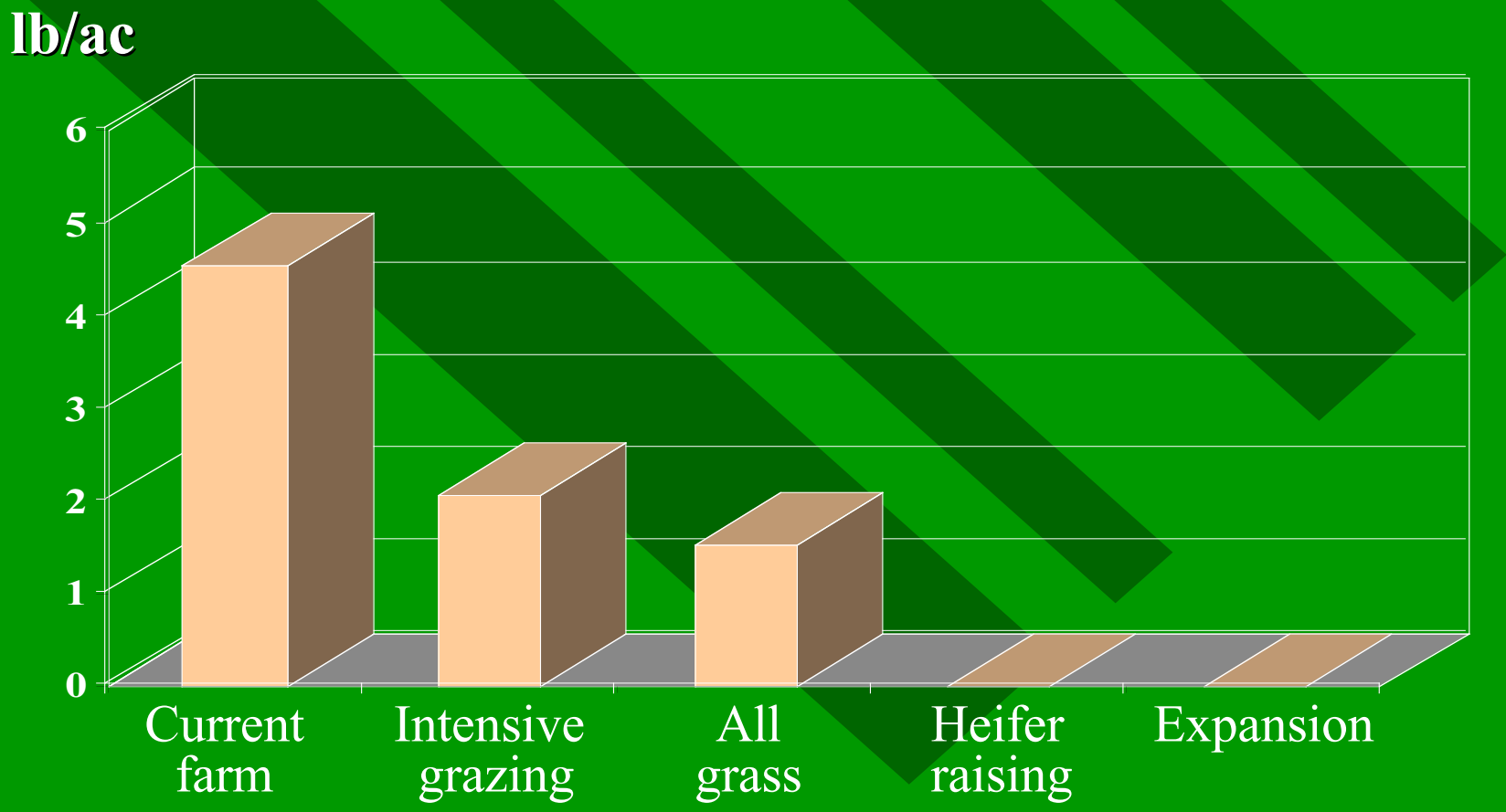
Management Options

- Use of intensive rotational grazing of lactating cows
- Conversion of all farm land to grass with rotational grazing
- Conversion of current dairy to heifer raising facility
- Expansion to a 250 cow confinement dairy facility, and less P fed (NRC, 2001)

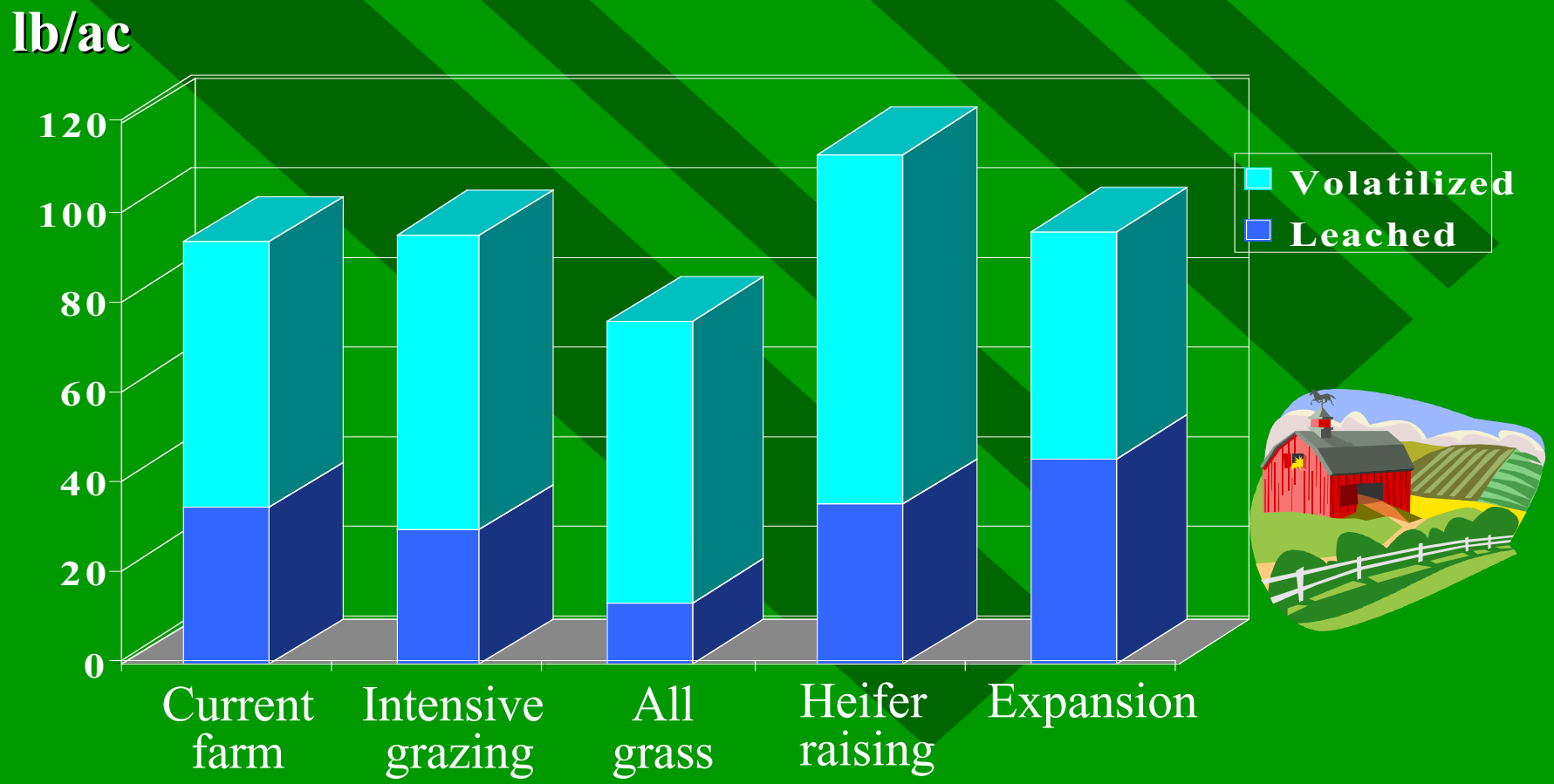
Feed Use


ton DM
3200
2800
2400
2000
1600
1200
800
400
0
Concentrate
Pasture
Corn silage
Forage
Current farm
Intensive grazing
All grass
Heifer raising
Expansion

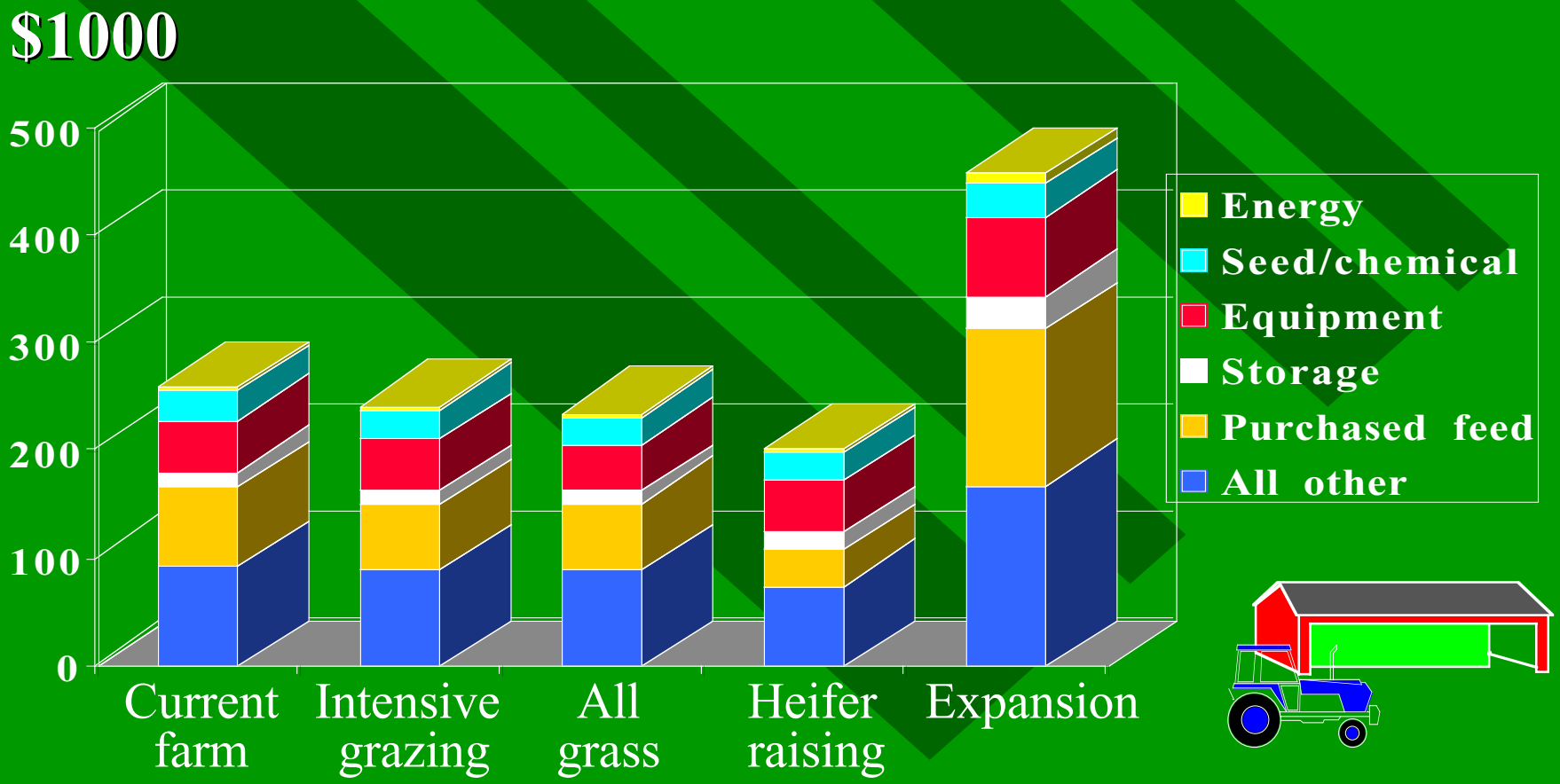
P Balance


lb/ac
6
5
4
3
2
1
0
Current farm
Intensive grazing
All grass
Heifer raising
Expansion

Nitrogen Losses



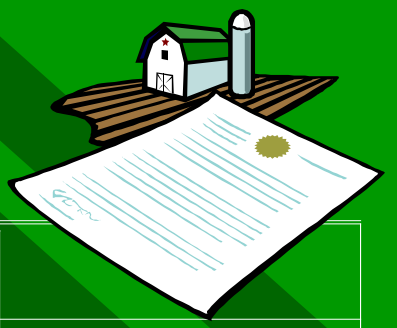
Production Costs



Net Return

$1000
350
300
250
200
150
100
50
0
Current farm
Intensive grazing
All grass
Heifer raising
Expansion

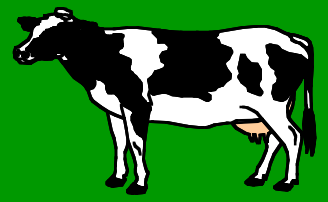
Risk



%
12
10
8
6
4
2
0
Current farm
Intensive grazing
All grass
Heifer raising
Expansion

Conclusions

- Current farms are doing an above average job with P management
- Management changes can reduce or eliminate the long-term accumulation of soil P on these NY dairy farms
- Reducing the level of dietary P and maximizing the use of farm-grown forage provided a P balance along with an increase in farm profit




Integrated Farm System Model
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Version 1.0
A tool for evaluating and comparing alternative technologies and management strategies on representative farms.
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For help, press F1
Beef Farm (CowCalf.fm)
10:20:56 AM Saturday, Dec 15, 2001

Future Plans

- Incorporate improved relationships for nutrient loss, particularly phosphorus
- Develop and incorporate a multiple plant species pasture component
- Complete development and verification of the beef animal component
- Use the model to evaluate alternative management strategies for dairy and beef production

http://pswmru.arsup.psu.edu

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